## Claims

1. A tire anti-puncture device comprising:

a puncture-resistant layer comprising at least two layers of woven fabric material, each layer having a taped fiber density of at least about 80% of full in at least one of the warp and fill and comprising fibers having a tenacity of less than about 15 g/denier, wherein the puncture-resistant layer is shaped and configured to form a belt within and around the periphery a tire.

2. The tire anti-puncture device of claim 1, wherein each of said layers of fabric has a bulk density, excluding any coatings applied to the fabric layers, that is at least about 20% of the density of any polymeric material forming the fibers of the fabric material.

3. The tire anti-puncture device of claim 1, further comprising at least one covering layer having an abrasion limit of less than about 2000 cycles as measured by a Tabor test utilizing a CS10 wheel with 1000 gram load, wherein the test is run to tensile failure, defined as the point where the tensile strength of the covering layer is reduced by about 25%.

4. The tire anti-puncture device of claim 1, wherein the puncture-resistant layer has a puncture resistance of greater than about 2.0 lbs. force, wherein the puncture resistance is defined as the level force required to force a 0.05 in. diameter polished steel commercial hand sewing needle through the puncture-resistant layer, when clamped and supported in a 1 in. diameter ring, such that the point of the needle projects from the side of the fabric opposite that to which the force is applied by a distance of about 0.045 inch.

5. The tire anti-puncture device of claim 1, wherein the at least two layers of fabric material are physically stacked upon each other without being bonded to each other.

6. The tire anti-puncture device of claim 1, wherein the at least two layers of fabric material are bonded to each other.

7. The tire anti-puncture device of claim 6, wherein the at least two layers are bonded together by an intermediate bonding layer.

8. The tire anti-puncture device of claim 7, wherein the intermediate bonding layer comprises materials that do not soften significantly at temperatures up to and including about 150 °F.

9. The tire anti-puncture device of claim 8, wherein the intermediate bonding layer comprises materials that do not soften significantly at temperatures up to about 300 °F.

10. The tire anti-puncture device of claim 6, wherein the at least two layers are bonded together by a mechanical process.

11. The tire anti-puncture device of claim 10, wherein the at least two layers are bonded together by needling.

12. The tire anti-puncture device of claim 1, wherein the device comprises a separable strip shaped and configured to be removably insertable within a tire.

13. The tire anti-puncture device of claim 1, wherein the device comprises a strip bonded to an inner surface of a tire.

14. The tire anti-puncture device of claim 1, wherein the device is located within the cross-section of a tire body.

15. The tire anti-puncture device of claim 14, wherein the device is located within the cross-section of a tire body on a tread-facing side of a cord layer of the tire body.

16. The tire anti-puncture device of claim 14, wherein the device is located within the cross-section of a tire body on a tube- or rim-facing side of a cord layer of the tire body.

17. The tire anti-puncture device of claim 1, wherein each layer of fabric material comprises fibers having a tenacity of less than about 8 g/denier.

18. The tire anti-puncture device of claim 18, wherein each layer of fabric material comprises fibers having a tenacity of between about 3 g/denier and about 8 g/denier.

19. The tire anti-puncture device of claim 1, wherein each layer of fabric material comprises polyamide fibers.

20. The tire anti-puncture device of claim 1, wherein each layer of fabric material comprises polyester fibers.

21. The tire anti-puncture device of claim 1, wherein each layer has a taped fiber density of at least about 85% of full in at least one of the warp and fill.

22. The tire anti-puncture device of claim 21, wherein each layer has a taped fiber density of at least about 95% of full in at least one of the warp and fill.

23. The tire anti-puncture device of claim 1, wherein yarns comprising the woven fabric material have a weight per unit length of between 20 denier and about 100 denier.

24. The tire anti-puncture device of claim 1, wherein the layers of fabric material have been densified by calendering or shrinking the layers.

25. The tire anti-puncture device of claim 1, wherein yarns comprising the woven fabric material are untwisted.

26. A tire comprising the tire anti puncture device of claim 1.

27. A tire anti-puncture device comprising:

a puncture-resistant layer comprising a woven fabric having a round packed cover factor of at least about 40% of full in the warp and at least about 65% of full in the fill, the fabric comprising fibers having a tenacity of less than about 15 g/denier, wherein the puncture-resistant layer is shaped and configured to form a belt within and around the periphery a tire.

28. The tire anti-puncture device of claim 27, wherein the woven fabric has a bulk density, excluding any coatings applied to the fabric, that is at least about 20% of the density of any polymeric material forming the fibers of the fabric material.

29. The tire anti-puncture device of claim 27, further comprising at least one covering layer having an abrasion limit of less than about 2000 cycles as measured by a Tabor test utilizing a CS10 wheel with 1000 gram load, wherein the test is run to tensile failure, defined as the point where the tensile strength of the covering layer is reduced by about 25%.

30. The tire anti-puncture device of claim 27, wherein the puncture-resistant layer has a puncture resistance of greater than about 2.0 lbs. force, wherein the puncture resistance is defined as the level force required to force a 0.05 in. diameter polished steel commercial hand sewing needle through the puncture-resistant layer, when clamped and supported in a 1 in. diameter ring, such that the point of the needle projects from the side of the fabric opposite that to which the force is applied by a distance of about 0.045 inch.

31. The tire anti-puncture device of claim 27, further comprising a coating applied to the woven fabric, the coating comprising a polymeric material that penetrates into and occupies at least a portion of the void space between fibers forming the fabric.

32. The tire anti-puncture device of claim 27, further comprising a coating applied as a liquid to the woven fabric, the applied coating, upon hardening, comprising a polymeric material having a bulk modulus not exceeding about 10,000 psi.

33. The tire anti-puncture device of claim 27, further comprising a coating applied as a liquid to the woven fabric, the applied coating, upon hardening, comprising a polymeric material having dispersed therein an abrasive particulate material.

34. The tire anti-puncture device of claim 27, wherein the puncture-resistant layer comprises a single layer of fabric material.

35. The tire anti-puncture device of claim 34, wherein the layer of fabric material has a a round packed cover factor of at least about 50% of full in the warp.

36. The tire anti-puncture device of claim 35, wherein the layer of fabric material has a a round packed cover factor of at least about 65% of full in the warp.

37. The tire anti-puncture device of claim 36, wherein the layer of fabric material has a a round packed cover factor of at least about 75% of full in the warp.

38. The tire anti-puncture device of claim 34, wherein the layer of fabric material has a a round packed cover factor of at least about 75% of full in the fill.

39. The tire anti-puncture device of claim 38, wherein the layer of fabric material has a a round packed cover factor of at least about 85% of full in the fill.

40. The tire anti-puncture device of claim 27, wherein the puncture-resistant layer comprises at least two layers of fabric material.

41. The tire anti-puncture device of claim 40, wherein the at least two layers of fabric material are bonded together.

42. The tire anti-puncture device of claim 27, wherein the device comprises a separable strip shaped and configured to be removably insertable within a tire.

43. The tire anti-puncture device of claim 27, wherein the device comprises a strip bonded to an inner surface of a tire.

44. The tire anti-puncture device of claim 27, wherein the device is located within the cross-section of a tire body.

45. The tire anti-puncture device of claim 44, wherein the device is located within the cross-section of a tire body on a tread-facing side of a cord layer of the tire body.

46. The tire anti-puncture device of claim 44, wherein the device is located within the cross-section of a tire body on a tube- or rim-facing side of a cord layer of the tire body.

47. The tire anti-puncture device of claim 27, wherein the woven fabric comprises fibers having a tenacity of less than about 8 g/denier.

48. The tire anti-puncture device of claim 47, wherein the woven fabric comprises fibers having a tenacity of between about 3 g/denier and about 8 g/denier.

49. The tire anti-puncture device of claim 27, wherein the woven fabric comprises polyamide fibers.

50. The tire anti-puncture device of claim 27, wherein the woven fabric comprises polyester fibers.

51. The tire anti-puncture device of claim 34, wherein yarns comprising the layer of woven fabric material have a weight per unit length of between 100 denier and about 500 denier.

52. A tire comprising the tire anti puncture device of claim 27.

53. A tire anti-puncture device comprising:

a puncture-resistant layer comprising at least two layers of fabric, each of said layers of fabric comprising fibers having a tenacity of less than about 15 g/denier and each of said layers of fabric having a bulk density, excluding any coatings applied to said fabric layer, that is at least about 20% of the density of any polymeric material forming the fibers of the fabric layers, wherein the puncture-resistant layer is shaped and configured to form a belt within and around the periphery a tire.

54. The tire anti puncture device if claim 53, wherein each of said layers of fabric has a bulk density, excluding any coatings applied to said fabric layer, that is between about 20% and about 45% of the density of any polymeric material forming the fibers of the fabric layers.

55. The tire anti puncture device if claim 53, wherein each of said layers of fabric has a bulk density, excluding any coatings applied to said fabric layer, of between about 0.3 $g/cm^3$ and about 0.6 $g/cm^3$.

56. The tire anti puncture device if claim 53, wherein the puncture-resistant layer has a puncture resistance of greater than about 2.0 lbs. force, wherein the puncture resistance is defined as the level force required to force a 0.05 in. diameter polished steel commercial hand sewing needle through the puncture-resistant layer, when clamped and supported in a 1 in. diameter ring, such that the point of the needle projects from the side of the fabric opposite that to which the force is applied by a distance of about 0.045 inch.

57. The tire anti puncture device if claim 53, further comprising at least one covering layer having an abrasion limit of less than about 2000 cycles as measured by a Tabor test utilizing a CS10 wheel with 1000 gram load, wherein the test is run to tensile failure, defined as the point where the tensile strength of the covering layer is reduced by about 25%.

58. The tire anti-puncture device of claim 53, further comprising a coating applied to at least one of the at least two layers of fabric, the coating comprising a polymeric material that penetrates into and occupies at least a portion of the void space between fibers forming the fabric.

59. The tire anti-puncture device of claim 53, further comprising a coating applied as a liquid to at least one of the at least two layers of fabric, the applied coating, upon hardening, comprising a polymeric material having a bulk modulus not exceeding about 10,000 psi.

60. The tire anti-puncture device of claim 53, further comprising a coating applied as a liquid to at least one of the at least two layers of fabric, the applied coating, upon hardening, comprising a polymeric material having dispersed therein an abrasive particulate material.

61. The tire anti-puncture device of claim 53, wherein at least one of the at least two layers of fabric comprises a non-woven fabric.

62. The tire anti-puncture device of claim 61, wherein each of the at least two layers of fabric comprises a non-woven fabric.

63. The tire anti-puncture device of claim 62, wherein each of the at least two layers of fabric comprises a knitted fabric.

64. The tire anti-puncture device of claim 62, wherein each of the at least two layers of fabric comprises a felted fabric.

65. The tire anti-puncture device of claim 62, wherein each of the at least two layers of fabric has a weight per unit area of between about 0.5 oz./sq. yd. and about 3 oz./sq. yd.

66. The tire anti-puncture device of claim 53, wherein at least one of the at least two layers of fabric comprises a woven fabric.

67. The tire anti-puncture device of claim 66, wherein each of the at least two layers of fabric comprises a woven fabric.

68. The tire anti-puncture device of claim 67, wherein each of the at least two layers of fabric comprises a woven fabric having a round packed cover factor of at less than about 40% of full in the warp and at less than about 65% of full in the fill.

69. The tire anti-puncture device of claim 67, wherein each of the at least two layers of fabric comprises a woven fabric having a taped fiber density of at less than about 80% of full in both the warp and fill.

70. The tire anti-puncture device of claim 67, wherein yarns comprising the woven fabric layers have a weight per unit length of between 20 denier and about 100 denier.

71. The tire anti-puncture device of claim 65, wherein each of the at least two layers of fabric has a weight per unit area of between about 0.5 oz./sq. yd. and about 3 oz./sq. yd.

72. The tire anti-puncture device of claim 53, wherein each layer of fabric comprises fibers having a tenacity of less than about 8 g/denier.

73. The tire anti-puncture device of claim 72, wherein each layer of fabric comprises fibers having a tenacity of between about 3 g/denier and about 8 g/denier.

74. The tire anti-puncture device of claim 53, wherein each layer of fabric comprises polyamide fibers.

75. The tire anti-puncture device of claim 53, wherein each layer of fabric comprises polyester fibers.

76. A tire comprising the tire anti puncture device of claim 53.

77. A tire anti-puncture device comprising:

a puncture-resistant layer comprising a single fabric layer, the fabric layer comprising fibers having a tenacity of less than about 15 g/denier and the fabric layer having a bulk density, excluding any coatings applied to the fabric layer that is at least about 30% of the density of any polymeric material forming the fibers of the fabric layer, wherein the puncture-resistant layer is shaped and configured to form a belt within and around the periphery a tire.

78. The tire anti-puncture device of claim 77, wherein said layer of fabric has a bulk density, excluding any coatings applied to said fabric layer, that is at least about 45% of the density of any polymeric material forming the fibers of the fabric layer.

79. The tire anti-puncture device of claim 78, wherein said layer of fabric has a bulk density, excluding any coatings applied to said fabric layer, that between about 45% and about 65% of the density of any polymeric material forming the fibers of the fabric layer.

80. The tire anti puncture device if claim 77, wherein said layer of fabric has a bulk density, excluding any coatings applied to said fabric layer, of between about 0.6 g/cm$^3$ and about 0.9 g/cm$^3$.

81. The tire anti puncture device if claim 77, wherein the puncture-resistant layer has a puncture resistance of greater than about 2.0 lbs. force, wherein the puncture resistance is defined as the level force required to force a 0.05 in. diameter polished steel commercial hand sewing needle through the puncture-resistant layer, when clamped and supported in a 1 in. diameter ring, such that the point of the needle projects from the side of the fabric opposite that to which the force is applied by a distance of about 0.045 inch.

82. The tire anti puncture device if claim 77, further comprising at least one covering layer having an abrasion limit of less than about 2000 cycles as measured by a Tabor test utilizing a CS10 wheel with 1000 gram load, wherein the test is run to tensile failure, defined as the point where the tensile strength of the covering layer is reduced by about 25%.

83. The tire anti puncture device if claim 77, further comprising a coating applied to said layer of fabric, the coating comprising a polymeric material that penetrates into and occupies at least a portion of the void space between fibers forming the fabric.

84. The tire anti puncture device if claim 77, further comprising a coating applied as a liquid to at least said layer of fabric, the applied coating, upon hardening, comprising a polymeric material having a bulk modulus not exceeding about 10,000 psi.

85. The tire anti-puncture device of claim 77, further comprising a coating applied as a liquid to said layer of fabric, the applied coating, upon hardening, comprising a polymeric material having dispersed therein an abrasive particulate material.

86. The tire anti-puncture device of claim 77, wherein said fabric layer comprises a woven fabric.

87. The tire anti-puncture device of claim 86, wherein yarns comprising the woven fabric layer have a weight per unit length of between 100 denier and about 500 denier.

88. The tire anti-puncture device of claim 86, wherein said layer of fabric has a weight per unit area of between about 3 oz./sq. yd. and about 15 oz./sq. yd.

89. The tire anti-puncture device of claim 77, wherein said fabric layer comprises a non-woven fabric.

90. The tire anti-puncture device of claim 89, wherein said layer of fabric has a weight per unit area of between about 0.5 oz./sq. yd. and about 3 oz./sq. yd.

91. The tire anti-puncture device of claim 89, wherein said layer of fabric comprises a knitted fabric.

92. The tire anti-puncture device of claim 89, wherein said layer of fabric comprises a felted fabric.

93. The tire anti-puncture device of claim 77, wherein said layer of fabric comprises fibers having a tenacity of less than about 8 g/denier.

94. The tire anti-puncture device of claim 93, wherein said layer of fabric comprises fibers having a tenacity of between about 3 g/denier and about 8 g/denier.

95. The tire anti-puncture device of claim 77, wherein said layer of fabric comprises polyamide fibers.

96. The tire anti-puncture device of claim 95, wherein said layer of fabric comprises polyester fibers.

97. A tire comprising the tire anti puncture device of claim 77.

98. A tire anti-puncture device comprising:

a puncture-resistant layer comprising at least one fabric layer comprising fibers having a tenacity of less than about 15 g/denier; and

at least one covering layer having an abrasion limit of less than about 2000 cycles as measured by a Tabor test utilizing a CS10 wheel with 1000 gram load, wherein the test is run to tensile failure, defined as the point where the tensile strength of the covering layer is

reduced by about 25%, wherein the puncture-resistant layer is shaped and configured to form a belt within and around the periphery a tire.

99. The tire anti-puncture product of claim 98, wherein the device comprises a separable strip shaped and configured to be removably insertable within a tire.

100. The tire anti-puncture device of claim 98, wherein the device comprises a strip bonded to an inner surface of a tire.

101. The tire anti-puncture device of claim 98, wherein the device comprises a single covering layer.

102. The tire anti-puncture device of claim 101, wherein the device is configured to be inserted within the interior of a tire body such that the covering layer faces an inner-tube within the interior of the tire body, when inserted within a tire.

103. The tire anti-puncture device of claim 101, wherein the width of the covering layer exceeds the width of the puncture resistant layer.

104. The tire anti-puncture device of claim 98, wherein the device comprises a two covering layers.

105. The tire anti-puncture device of claim 104, wherein the puncture resistant layer is positioned between the two covering layers.

106. The tire anti-puncture device of claim 105, wherein the width each of the covering layers exceeds the width of the puncture resistant layer.

107. The tire anti-puncture product of claim 98, wherein the puncture-resistant layer and the at least one covering layer are physically stacked upon each other without being bonded to each other.

108. The tire anti-puncture device of claim 98, the puncture-resistant layer and the at least one covering layer are bonded to each other.

109. The tire anti-puncture device of claim 108, wherein the puncture-resistant layer and the at least one covering layer are bonded to each other by at least one intermediate bonding layer.

110. The tire anti-puncture device of claim 109, wherein the intermediate bonding layer comprises materials that do not soften significantly at temperatures up to and including about 150 °F.

111. The tire anti-puncture device of claim 110, wherein the intermediate bonding layer comprises materials that do not soften significantly at temperatures up to about 300 °F.

112. The tire anti-puncture device of claim 108, wherein the puncture-resistant layer and the at least one covering layer are bonded to each other by a mechanical process.

113. The tire anti-puncture device of claim 112, wherein the puncture-resistant layer and the at least one covering layer are bonded to each other by needling.

114. A tire comprising the tire anti puncture device of claim 98.

115. A tire anti-puncture device comprising:

a puncture-resistant layer comprising a fabric comprising fibers having a tenacity of less than about 15 g/denier, the puncture-resistant layer further having a puncture resistance of greater than about 2.0 lbs. force, wherein the puncture resistance is defined as the level force required to force a 0.05 in. diameter polished steel commercial hand sewing needle through the puncture-resistant layer, when clamped and supported in a 1 in. diameter ring, such that the point of the needle projects from the side of the fabric opposite that to which the force is applied by a distance of about 0.045 inch, wherein the puncture-resistant layer is shaped and configured to form a belt within and around the periphery a tire.

116. The tire anti-puncture device of claim 115, wherein the puncture-resistant layer has a puncture resistance of greater than about 3.0 lbs. force, wherein the puncture resistance is defined as the level force required to force a 0.05 in. diameter polished steel commercial hand sewing needle through the puncture-resistant layer, when clamped and supported in a 1 in. diameter ring, such that the point of the needle projects from the side of the fabric opposite that to which the force is applied by a distance of about 0.045 inch.

117. A tire comprising the tire anti puncture device of claim 115.

118. A tire anti-puncture device having a puncture-resistant layer comprising:

at least one fabric layer comprising fibers having a tenacity of less than about 15 g/denier; and

a coating applied to the fabric layer, the coating comprising a polymeric material that penetrates into and occupies at least a portion of the void space between fibers forming the fabric, wherein the puncture-resistant layer is shaped and configured to form a belt within and around the periphery a tire.

119. The tire anti-puncture device of claim 118, wherein the puncture-resistant layer comprises a single layer of fabric.

120. The tire anti-puncture device of claim 118, wherein the puncture-resistant layer comprises at least two fabric layers.

121. The tire anti-puncture device of claim 118, wherein the coating is applied as a liquid to the fabric layer, the applied coating, upon hardening, comprising a polymeric material having a bulk modulus not exceeding about 10,000 psi.

122. The tire anti-puncture device of claim 118, wherein the coating is applied as a liquid to the fabric layer, the applied coating, upon hardening, comprising a polymeric material having a bulk modulus exceeding about 10,000 psi.

123. The tire anti-puncture device of claim 118, wherein the coating is applied as a liquid to the fabric layer, the applied coating, upon hardening, comprising a polymeric material having dispersed therein an abrasive particulate material.

124. A tire comprising the tire anti puncture device of claim 118.

125. A tire anti-puncture device having a puncture-resistant layer comprising:

at least one fabric layer comprising fibers having a tenacity of less than about 15 g/denier; and

a coating applied as a liquid to the fabric layer, the applied coating, upon hardening, comprising a polymeric material having a bulk modulus not exceeding about 10,000 psi, wherein the puncture-resistant layer is shaped and configured to form a belt within and around the periphery a tire.

126. The tire anti-puncture device of claim 125, wherein the applied coating, upon hardening, comprises a polymeric material having dispersed therein an abrasive particulate material.

127. The tire anti-puncture device of claim 125, wherein the applied coating, upon hardening, comprises a polymeric material having a bulk modulus not exceeding about 2,000 psi.

128. The tire anti-puncture device of claim 127, wherein the applied coating, upon hardening, comprises a polymeric material having a bulk modulus not exceeding about 1,500 psi.

129. The tire anti-puncture device of claim 128, wherein the applied coating, upon hardening, comprises a polymeric material having a bulk modulus of between about 500 psi and about 1,500 psi.

130. A tire comprising the tire anti puncture device of claim 125.

131. A tire anti-puncture device having a puncture-resistant layer comprising:

at least one fabric layer comprising fibers having a tenacity of less than about 15 g/denier; and

a coating applied as a liquid to the fabric layer, the applied coating, upon hardening, comprising a polymeric material having dispersed therein an abrasive particulate material, wherein the puncture-resistant layer is shaped and configured to form a belt within and around the periphery a tire.

132. The tire anti-puncture device of claim 131, further comprising two covering layers each having an abrasion limit of less than about 2000 cycles as measured by a Tabor test utilizing a CS10 wheel with 1000 gram load, wherein the test is run to tensile failure, defined as the point where the tensile strength of the covering layer is reduced by about 25%, wherein the puncture-resistant layer is positioned between the two covering layers and the width of each of the two covering layers exceeds the width of the puncture-resistant

133. A tire comprising the tire anti puncture device of claim 131.